U. S. FOREST SERVICE

RESEARCH NOTE LS-28

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# Ground Preparation Costs and First-year Survival of Planted Red Pine in Southwestern Wisconsin[1]

Low cost and relative ease of preparing the ground and planting the trees are primary considerations for farmers and other owners of open land with a potential for reforestation. Therefore, many prefer mechanized methods, providing costs are reasonable.

In 1962 a study involving 40 rows of 100 trees each was initiated on the Coulee Experimental Forest near La Crosse, Wis., to compare two age classes and five methods of ground preparation and planting. There were eight rows of each method. The site was on the lower third of a 26- to 28-percent slope on an abandoned pasture. The soil is mapped as Hixton sandy loam; and the site, formerly forested, is 940 feet above sea level. Prior to planting, it had a medium-density stand of young, 1- to 3-foot-high sumac sprouts. The main ground cover was bluegrass, which offered only moderate competition to planted trees.

### *Treatments Used in Study*

*Treatment 1.*—Contour bench terraces, 12 to 16 inches wide, were made with a light John Deere crawler tractor equipped with a 6-foot-wide adjustable angle-dozer blade. The ground preparation went exceptionally well in spite of having to "deadhead" the full length of the plot to start each new row. It was deemed cheaper to do this than to change the angle of the blade manually for each return trip. Prior removal of the long, dry bluegrass by prescribed burn (summer 1961) and of the large stems of sumac by cutting, piling, and burning, plus ideal soil-moisture content, facilitated ground preparation.

*Treatments 2 and 3.*—Single and double furrows were made by an Allis Chalmers D-17 – a heavy, rubber-tired tractor – pulling a reversible, two-way plow with four plowshares on it. For single furrowing (treatment 2) the outer plows were removed. To avoid damaging the plows, they were raised whenever stumps 2 inches in diameter or larger were encountered. The reversible plow had the advantage of throwing all furrow slices downhill without a deadheading operation and produced clean, open furrows. (When the furrow slice is thrown uphill on such sloping land, it often flops back into the furrow and closes it; later it has to be chopped out before planting a tree.)

*Treatment 4.* – The Lowther planting machine was also tested. This 1,600-pound, heavy-duty, crank-axle machine was pulled by a light crawler tractor (a Case 310) with dozer blade. With this equipment, plowing and planting are done in one operation. The work went reasonably well, considering the steep slope and short rows (400 feet long) which slowed up the operation because of time lost in turning. Furthermore, the planter had to be raised to clear scattered apple and thornapple stumps and prevent damage to equipment. Since all rows were made on the contour, they had gentle curves toward the end. On these curves, the wheel packer failed to firm about 15 to 20 percent of the 800 trees satisfactorily. In a separate operation, it required an hour and 10 minutes for one man to straighten and firm or repack the loose or fallen trees.

*Treatment 5.* – Scalps about 10 inches square were prepared by hand with a narrow-bladed planting mattock.

### *Cost of Ground Preparation and Planting*

The lowest cost per 1,000 trees planted was achieved by the Lowther machine ($13.38 per 1,000 trees) (table 1). It was followed closely by single furrows made with a two-way plow and hand planted ($14.01 per 1,000 trees). The hand-scalping operation was surprisingly cheap, $15.53 per 1,000 trees. The crew was well trained and efficient, and all had previous planting experience.

[1] *The research reported here was conducted in cooperation with the Wisconsin Conservation Department.*

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TABLE 1. — *Time and cost for ground preparation and planting on a 26- to 28-percent slope Coulee Experimental Forest, Wis.*

| Ground preparation and planting methods[1] | Ground preparation time per mile of row[2] | Planting time per mile of row[2] | Average cost of operation per mile of furrow for both age classes used[3] | | | |
|---|---|---|---|---|---|---|
| | | | Ground preparation | Planting | Total | Total per 1,000 trees |
| | Hours | Hours | Dollars | Dollars | Dollars | Dollars |
| Bench terrace with angle dozer (H) | 0.85 | 11.22 | 5.95 | 14.69 | 20.64 | 15.64 |
| Single furrow with two-way plow (H) | .88 | 11.77 | 3.08 | 15.41 | 18.49 | 14.01 |
| Double furrow with two-way plow (H) | 1.79 | 12.21 | 6.26 | 16.00 | 22.26 | 16.86 |
| Lowther[4] | -- | 1.48 | [5]1.53 | 16.13 | 17.66 | 13.38 |
| Scalps (H) | 3.66 | 11.99 | 4.79 | 15.71 | 20.50 | 15.53 |

[1] *(H) refers to hand planting with mattocks by center-hole method.*

[2] *Time is expressed in man- or machine-hours and includes turning time at end of rows. Values do not include transport time to and from the job; time studies began when the equipment or men were on the planting site ready to go. Nursery stock costs are excluded in the table. Spacing of plants within rows was 4 feet, or at the rate of 1,320 trees per mile of row.*

[3] *Basic costs were as follows:*
*a. Angle dozer $7 per hour including driver.*
*b. Single and double furrows by wheel tractor at $3.50 per hour including driver.*
*c. Labor for scalping and hand planting at $1.31 per hour.*
*d. Total costs for the Lowther planting machine operation were $10.90 per hour. Items were: crawler tractor to pull Lowther planter at $7 per hour including driver; man on Lowther planting machine doing planting at $1.50 per hour; rental charge on the Lowther machine at $3.00 per 1,000 trees or $2.40 per hour.*

[4] *Ground preparation and planting were accomplished in the same operation by the Lowther tree planting machine.*

[5] *This item is for firming the loose trees by heel after the planting machine had passed.*

The double furrow proved to be the most expensive of any of the ground preparation methods ($16.86 per 1,000 trees). The chief reason was the time lost in pulling out sumac roots and chunks of sod wedged between the closely spaced plows. Single furrowing had no such problem. The angle dozer moved at a good pace, and, although a more expensive piece of equipment, it was cheaper per 1,000 trees than the double furrows made by wheel tractor.

Hand planting time and costs in the four methods of ground preparation (excluding the mechanical planter) were:

| *Ground preparation method* | *Man-hours per 1,000 red pine* 3-0 stock | 2-1 stock | Average | *Ratio to scalping* |
|---|---|---|---|---|
| Bench terrace with angle dozer | 8.33 | 8.67 | 8.50 | 0.94 |
| Single furrow with two-way plow | 9.00 | 8.83 | 8.91 | .98 |
| Double furrow with two-way plow | 8.17 | 10.33 | 9.25 | 1.02 |
| Scalps | 9.33 | 8.83 | 9.08 | 1.00 |

Planting time was lowest (8.50 hours per 1,000 trees) in the bench terraces made by the angle dozer; these were about 12 to 16 inches wide and easiest to walk on and to plant. The other methods ranged from 8.91 to 9.25 hours per 1,000 trees. Differences in rate of planting between 3-0 and 2-1 were minor. (For this reason the cost data in table 1 were pooled for both age classes.) The planting time per tree for 1,600 trees for each age class was 0.523 man-minute for 3-0 versus 0.550 man-minute for 2-1, or a mere 5-percent difference. All hand planting was done with mattocks by the center-hole method. Stock costs were $15 and $27 per 1,000 trees for the 3-0 and 2-1 age classes respectively.

### *Cost of Preliminary Brush Cutting and Aftercare*

A prescribed burn was run over the area in 1961 in the year before planting, and all sumac brush (5 to 8 feet high) and scattered brush were cut, piled, and burned at a cost of $23.58 per 1,000 trees planted. Of this cost, about half can be considered as applicable to a larger scale operation and half as an additional research cost due to experimental requirements.

TABLE 2. — *First-year survival and percent of planted red pine growing vigorously*
*(In percent)*

| Ground preparation method | First-year survival | | High-vigor trees | | |
|---|---|---|---|---|---|
| | 3-0 | 2-1 | 3-0 | 2-1 | Difference in favor of 2-1 |
| Bench terrace with angle dozer | 90.0 | 95.2 | 72.0 | 89.2 | 17.2 |
| Single furrow with two-way plow | 94.0 | 96.0 | 76.2 | 86.7 | 10.5 |
| Double furrow with two-way plow | 89.5 | 91.7 | 63.5 | 82.5 | 19.0 |
| Lowther | 93.0 | 95.5 | 72.2 | 85.7 | 13.5 |
| Scalps | 84.7 | 94.5 | 61.5 | 84.2 | 22.7 |
| Average | 90.2 | 94.6 | 69.1 | 85.7 | 16.6 |

Some resprouting of sumac occurred, and such sprouts as actually interfered with the individual trees were cut the following year. The labor and costs of release cutting in summer 1962 were:

| *Ground preparation treatment* | *Man-hours per 1,000 trees* | *Cost per 1,000 trees* |
|---|---|---|
| Bench terrace with angle dozer | 4.47 | $5.86 |
| Single furrow with two-way plow | 5.31 | 6.96 |
| Double furrow with two-way plow | 4.71 | 6.28 |
| Lowther | 5.73 | 7.51 |
| Scalps | 5.41 | 7.09 |

Brush cutting was cheapest on the land prepared by angle dozer. On this land, much of the resprout growth of summer 1961 had been smashed down and broken the next spring during ground preparation; furthermore, the ground preparation job itself was somewhat better. Thus, the angle dozer has an advantage of $1.23 over scalps and $1.65 over the Lowther in terms of first-year aftercare in brush cutting.

### *Survival and Vigor*

The only significant differences in survival between ground preparation methods were in 3-0 red pine where both the Lowther method and single furrow were better than scalps at the .10 level of significance (table 2). Between age classes within the same ground preparation method, only in scalps were transplants statistically superior to seedlings — in this case at the .05 level.

When trees were classified by vigor, there was an overall advantage in favor of transplants over seedlings. The average is 16.6 percent (table 2). The maximum was 22.7 percent in ground prepared by scalping. The advantage of 2-1 over 3-0 is significant at, or better than, the .05 level in all five ground preparation methods.

Some contrast also appears in terms of percent of vigorous trees between ground preparation methods — all comparisons favoring furrowing of some type over scalps. Specifically for 3-0 stock, the single furrow was better than scalps at the .05 level and angle dozing over scalps at .10 level. For 2-1 stock, differences between ground preparation methods were minor, and only angle dozing showed any superiority; it was better than double furrows at the .10 level of significance.

### *Evaluation of the Ground Preparation and Planting Methods*

Considering costs and survival and the general ease of accomplishing the job, the Lowther mechanical tree planter was the most efficient on this site (slope of 26 to 28 percent). It is followed closely by single furrow with hand planting. The results are in general agreement with those of Merz and

Funk.[2] The steepness of the slope and the number of stumps encountered were about a maximum for use of this type of mechanical tree planter. However, many planting sites in the Driftless Area are of this degree of slope or less and many have no stumps whatever, so it would appear as the preferred method of the five used.

On the other hand, farmers having their own furrowing or terracing equipment may well choose to use their own equipment and do their own ground preparation and planting to reduce their actual cash outlay for the reforestation job. Plowing of single furrows with a reversible plow seems feasible on any slopes that the Lowther can operate on — i.e., up to about 30 percent. The angle dozer can be safely used at a satisfactory production rate on slopes up to around 40 percent, providing the land has few, if any, outcrops of sandstone or limestone and comparatively little loose rock on the surface. On very steep, rocky land (over 40-percent slope) both ground preparation and planting will probably have to be done by hand.

All costs for the type of site involved in the study are in the range of 5.2 to 6.8 cents per surviving tree for 3-0 stock; the average is 5.5. The lowest costs are 5.2 cents in single furrows and 5.3 cents by Lowther machine. For 2-1 stock the range is 6.4 to 6.9 cents per tree and the average 6.6 cents for the five planting and ground preparation methods. The average cost per tree for single furrows and the Lowther machine is 6.4 cents. These figures per surviving tree include all costs of ground preparation, planting, stock, and aftercare, plus a preliminary clearing cost of 1.4 cents per tree.

The range of costs and first-year results are fairly narrow in this particular trial, and the method of ground preparation or age class chosen could be heavily influenced by the type of equipment available on the farm or for rent nearby, the amount of money the landowner was inclined to spend for nursery stock, and his choice on expending his own labor on hand planting versus hiring a planting machine.

[2] *Merz, Robert W., and Funk, David J. Preplanting ground preparation tests for white pine in southeastern Ohio. U.S. Forest Serv., Central States Forest Expt. Sta. Tech. Paper 167, 8 pp. 1959.*

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